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### ㉛ Relief valve.

㉜ A relief valve for low pressure operation includes a valve body (12) having an enlarged cylindrical bore (20) in alignment with an Inlet port (16) and defining a valve chamber (22). An outlet port (18) opens laterally from the valve chamber (22). A seat insert (80) is received in the bore (20) and defines an axially facing raised seat (92) circumferentially about the inlet port (16) at a location closely adjacent the outlet port (18). A poppet valve member (50) with a truncated conical configuration and a maximum outer diameter only slightly less than the inner diameter of the enlarged bore (20) is mounted for engaging the seat (92) and blocking flow through the inlet (16). A biased stem (44) extends into the valve chamber (22) in axial alignment with the seat (92). The stem (44) has a cylindrical end portion which is received in a cylindrical opening (110) formed axially into the poppet valve member (50) on the end thereof opposite the seat insert (80). The cylindrical end portion and the cylindrical opening are sized to permit lateral shifting and alignment of the poppet valve member (50) relative to the seat (92) while preventing excessive and unwanted tilting of the poppet valve member (50) relative to the bore (20).

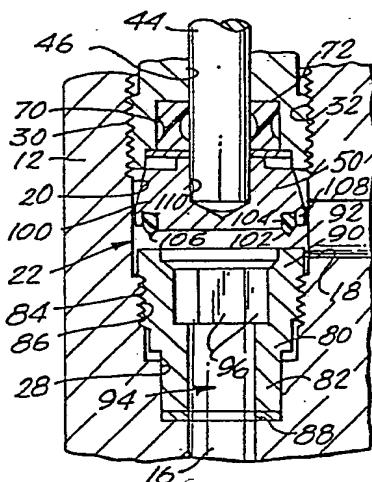


FIG. 2

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## Description

## RELIEF VALVE

The invention relates to valves and, more particularly, to pressure relief valves.

The invention is particularly suited for embodiment in an adjustable low pressure relief valve and will be described with special reference thereto, however, the invention is capable of broader application and could be incorporated in a variety of types and styles of check valves and pressure relief valves.

In US-A- 4,530,373 there is disclosed a pressure relief valve design which is particularly adapted for use in high pressure applications. Although the design can be used in low pressure applications, it incorporates a relatively small diameter valve element. In low pressure applications this small diameter results in a comparatively small area against which the upstream pressure can act for generating the opening force. As a consequence, the opening force is relatively small. With small forces available for opening the valve, it is difficult to assure that the valve will open consistently at the desired pressure setting. That is small changes in spring force, friction, valve sticking, etc. will produce significant changes in the pressure at which opening takes place.

It has, accordingly, been considered desirable to provide a pressure relief valve design which assures consistent operation throughout a wide range of low pressure settings.

Accordingly, one object of the invention is the provision of a pressure relief valve which is especially suited for low pressure operation.

Another object is the provision of a valve of the type described wherein the effective area of the valve element is substantially equal to the cross-sectional area of the valve chamber.

Yet another object is the provision of a pressure relief valve wherein the valve element is mounted in a manner which permits it to shift laterally to achieve alignment with the seat while being limited against undesirable tilting.

A further object is the provision of a pressure relief valve wherein the valve element is carried and guided by a stem which is mounted for sliding movement in a bonnet.

The subject invention assures the desired consistency in operation by providing a valve element and seat design which are related to the inlet and outlet ports in a manner that greatly increases the force available for valve operation. Moreover, the design allows the same basic valve body and adjustment mechanism to be used for both the prior design and the improved low pressure design.

According to the present invention, a pressure relief valve comprising a valve body which has an axial inlet port, a lateral outlet port and an enlarged cylindrical bore which is in alignment with the inlet port, the cylindrical bore forming a valve chamber with which the outlet port communicates, a poppet valve member disposed in said valve chamber for co-operation with an axially facing valve seat about the inlet port, a bonnet screw threadably received in

the end of the enlarged cylindrical bore opposite the inlet port, a valve stem carried in said bonnet in axial alignment with the valve seat for actuating the valve member and means for maintaining the valve stem under a predetermined bias to urge the valve member towards the valve seat, is characterised in that the axially facing valve seat is a raised seat defined on a seat insert which is screw-threadably received in said enlarged cylindrical bore, and in that the poppet valve element has a truncated conical configuration with a maximum outer diameter only slightly less than the diameter of said enlarged bore and has an axial cylindrical opening at its end remote from its valve face, a cylindrical end portion of the stem being received in such cylindrical opening which is so sized relative to such end portion of the stem as to permit lateral shifting and alignment of the poppet valve member relative to the seat while preventing excessive unwanted tilting of the poppet valve member relative to the enlarged bore.

Preferably, the maximum outer diameter of the poppet valve member is located closely adjacent the end face and is sized to provide guiding movement on the inner diameter of the enlarged bore.

The relationship described results in the poppet member being guided from both the interior wall of the valve chamber and the exterior surface of the stem. In addition, the relationship between the stem and the opening in the poppet member is such as to prevent tilting and binding of the poppet member in the valve chamber.

As a consequence of the above, the poppet valve member can have an effective area exposed to upstream fluid pressure which is substantially equal to the diameter of the valve chamber. This increases the effective area over which opening force is generated and is especially advantageous for low pressure operation. Moreover, because the valve seat is substantially at or closely adjacent the outlet, fluid flow from the inlet to the outlet does not have to pass about the periphery of the poppet valve member. Rather, opening of the poppet member allows flow to go in the lateral direction directly from the inlet to the outlet.

The invention is further described by way of example, with reference to the accompanying drawings wherein:

Fig.1 is a sectional elevational view of a pressure relief valve constructed in accordance with the present invention; and

Fig. 2 is an enlarged view of part of Fig.1 but showing the valve in an open position.

Fig.1 of the drawings shows the overall arrangement of a pressure relief valve 10 including a valve body 12 and a co-operating bonnet 14. The valve body 12 is formed from any suitable material, such as stainless steel, and includes an axially extending inlet port 16 and a laterally extending outlet port 18. An enlarged, stepped diameter bore 20 extends axially inward from the upper end of body 12 and defines a valve chamber 22. In the embodiment

shown, the body 12 is provided with pipe thread type fittings for permitting the valve to be connected to associated piping systems. Specifically, the inlet port 16 is provided with a male pipe thread connection 24 and the lateral outlet port 18 is provided with a female pipe thread connection 26. Other types of fittings could obviously be used.

The bore 20 has a stepped diameter with a reduced diameter innermost section 28 which is located beneath the lateral outlet 18. The bore 20 is axially aligned with the inlet port 16 and has its upper end closed by the bonnet 14. As shown, the lower end of bonnet 14 has external threads 30 formed thereon to mate with threads 32 in the upper end of bore 20. At the outermost or upper end the bore 20 is provided with a conical chamfer 34 which co-operates with the exterior of the bonnet 14 to define a seal receiving cavity 36. In the embodiment shown, an O-ring 38 is received within the cavity 36 to provide a fluid tight seal about the upper end of the valve chamber 22. The central section 40 of the bonnet 14 is radially enlarged and acts to compress the O-ring 38 in the cavity 36. Preferably, the external radial surface of the enlarged portion 40 is provided with a hexagonal or other polygonal external shape for engagement by a wrench or the like for installation and removal of the bonnet 14.

Slidably carried within the bonnet 14 is a valve stem 44 acting also as a poppet valve guide. As shown, the stem 44 is slidably received within a stepped diameter axial bore 46. The stem 44 is of a corresponding stepped diameter with a relatively large diameter lower end portion and a smaller diameter upper end portion. The lower end of the stem 44 extends into the valve chamber 22 and receives a poppet valve element 50 in a manner subsequently to be described. The upper free end of the stem 44 extends into an axially extending chamber 52 formed inwardly from the upper end of the bonnet 14.

The stem 44 is maintained under a continual downward bias by an adjustable compression spring assembly 54 carried in the bore 52. The adjustable spring assembly 54 includes a circular support disc 56 which is closely received in the bore 52 and bears against the upper end of the reduced diameter end portion of stem 44. In the embodiment shown, the disc 56 has a conical recess formed in each side thereof so that the disc can be assembled into the bore 52 in either direction. Carried or bearing against the upper face of disc 56 is a compression spring 58 which is maintained under an adjustable compression force by a cap member 60. The cap member 60 is internally threaded at 62 and engages with external thread 64 formed on the outer end of the bonnet 14. Axial adjustment of the cap 60 varies the compressive force applied through spring 58 to the stem 44 and, in turn, the poppet valve 50. Preferably, a lock nut 68 is received on the external threads 64 to engage with the undersurface of cap 60 to lock the cap in its axially adjusted position.

Formed about the lower end of stem 44 and extending into the bonnet 14 is a counterbore 70. A seal ring in the form of a quad-ring 72 is positioned in the counterbore 70 in surrounding and sealing

relationship with the lower end of stem 44. The quad-ring 72 is maintained properly compressed within the recess 70 by a push-in retainer ring 74 received within a second relatively shallow counterbore 76.

The valve thus far disclosed and described is substantially as shown in US-A- 4,530,373. The primary differences between the present valve and that shown in the noted patent are to be found in the design and operational relationships within the valve chamber 22.

Referring specifically to Fig.2, an insert member 80 defining a valve seat is threadably mounted in the lower end of the stepped diameter bore 20. The insert 80 has a reduced diameter end portion 82 which is closely received in the reduced diameter innermost section 28 of the bore 20. Threads 84 are formed about the exterior of the insert 80 for co-operation with threads 86 formed internally of the bore 20. A seal member 88 is positioned at the lower end of the bore 20 for sealing engagement with the end face of insert 80.

At its upper end, the insert 80 has a circumferentially extending end portion 90 which defines a raised, axially facing seat 92. The seat 92 is located substantially at the elevation of the lateral outlet 18. A central passage 94 extends through the insert 80, connecting the seat area 92 with the inlet port 16. Within the passageway 94 there are provided co-operating wrench flats 96. Specifically, the interior of the passage 94 has a hexagonal cross-section to form a socket which can receive a standard hexagonal wrench or the like. This allows the insert 80 to be readily installed in and removed from the bore 20.

As discussed, the seat area 92 is located at an elevation substantially corresponding to the lateral outlet 18. In addition, the seat preferably is in a plane transverse to the axis of the bore 20. As shown, the seat 92 is closely adjacent the wall of the bore 20 so that the area enclosed by the seat is at a substantial maximum.

Co-operating with the seat to seal flow from the inlet 16 to the outlet 18 is the previously mentioned poppet valve member 50. Poppet member 50 comprises a relatively thick disc-like body 100. A seal member 102 is carried on the lower face of the body 100. Specifically, the seal 102 is bonded in an axially extending, circumferential groove 104 formed about the outer periphery of the lower face of body 100. Preferably, the seal 102 is shaped as shown in Fig.2 and tapers to a relatively narrow sealing edge portion 106. The flange 108 about the exterior of the seal 102 has an axial length which is less than that of the centre portion of the body 100. This provides space for the seal material to extrude or deform when the valve is subject to an extremely high back pressure. In addition, under high back pressure conditions, a metal-to-metal seal can occur between the body 100 and the area immediately about the inside of the seal 102 and the inner portion of the seat 92.

The poppet body 100 is slidably carried on the lower, large diameter end of the stem member 44. In this regard, the body 100 has a blind bore 110 which

is sized slightly larger than the exterior diameter of the stem 44. In addition, the bore 110 extends a significant distance axially into the body 100. The relative dimensions of the stem 44 and the opening 110 are such as to limit the tilting that the poppet can undergo relative to the stem while permitting some lateral shifting between the poppet and stem for assuring centering of the poppet within the bore 20. With respect to the guiding and shifting of the poppet 50, the poppet body 100 has a generally truncated conical configuration with its largest diameter located on a plane substantially corresponding to the plane of the seal 102. This diameter of the poppet body is only slightly smaller than the inner diameter of the bore 20. This allows the poppet to obtain guidance with the inner wall of the bore. In addition, the truncated conical shape allows the poppet to tilt slightly in the bore without binding against the walls of the bore.

As shown in Fig.2, when the poppet is in an open position it backseats against the lower end of the bonnet member 40. In addition, when in the open position flow from the inlet port 16 can take place directly to the outlet without flowing about the poppet element 50. The arrangement described allows the lower face of the poppet exposed to the upstream pressure to have a maximum effective area. This is achieved without significant modification of the valve body or bonnet assembly. Thus, one basic valve body and bonnet assembly can be used for both extremely high pressure operation and low pressure operation.

Modifications and alterations of the preferred embodiment as described and illustrated are included within the scope of the claims.

### Claims

1. A pressure relief valve comprising a valve body (12) which has an axial inlet port (16), a lateral outlet port (18) and an enlarged cylindrical bore (20) which is in alignment with the inlet port (16), the cylindrical bore (20) forming a valve chamber (22) with which the outlet port (18) communicates, a poppet valve member (50) disposed in said valve chamber (22) for co-operation with an axially facing valve seat (92) about the inlet port (16), a bonnet (14) screw threadably received in the end of the enlarged cylindrical bore (20) opposite the inlet port (16), a valve stem (44) carried in said bonnet (14) in axial alignment with the valve seat (92) for actuating the valve member (50) and means (54) for maintaining the valve stem under a predetermined bias to urge the valve member (50) towards the valve seat (92), characterised in that the axially facing valve seat (92) is a raised seat defined on a seat insert (80) which is screwthreadably received in said enlarged cylindrical bore (20), and in that the poppet valve element (50) has a truncated conical configuration with a maximum outer diameter only slightly less than the diameter of said enlarged bore (20) and has an axial cylindrical opening (110) at its end remote from its

valve face, a cylindrical end portion of the stem (44) being received in such cylindrical opening (110) which is so sized relative to such end portion of the stem (44) as to permit lateral shifting and alignment of the poppet valve member (50) relative to the seat (92) while preventing excessive unwanted tilting of the poppet valve member (50) relative to the enlarged bore (20).

- 5 2. A pressure relief valve as claimed in claim 1, wherein said poppet valve member (50) includes a resilient seal portion (106) located circumferentially of its end face at a radius to engage said raised seat (92).
- 10 3. A pressure relief valve as claimed in claim 1 or 2, wherein said seat insert (80) has tool-receiving surfaces (96) formed centrally thereof for permitting installation and removal of said seat insert.
- 15 4. A pressure relief valve as claimed in claim 1, 2 or 3, wherein the maximum outer diameter of said poppet valve member (50) is located closely adjacent to its end face and is sized to provide guiding movement on the diameter of said enlarged bore (20).
- 20 5. A pressure relief valve as claimed in any of claims 1 to 4, wherein said seat insert (80) has a stepped outer diameter.
- 25 6. A pressure relief valve as claimed in any of claims 1 to 5, wherein said stem (44) extends a substantial distance into said poppet valve member (50).
- 30 7. A pressure relief valve as claimed in any preceding claim, in which the outlet port (18) is substantially in alignment with the raised valve seat (22).
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FIG. 1

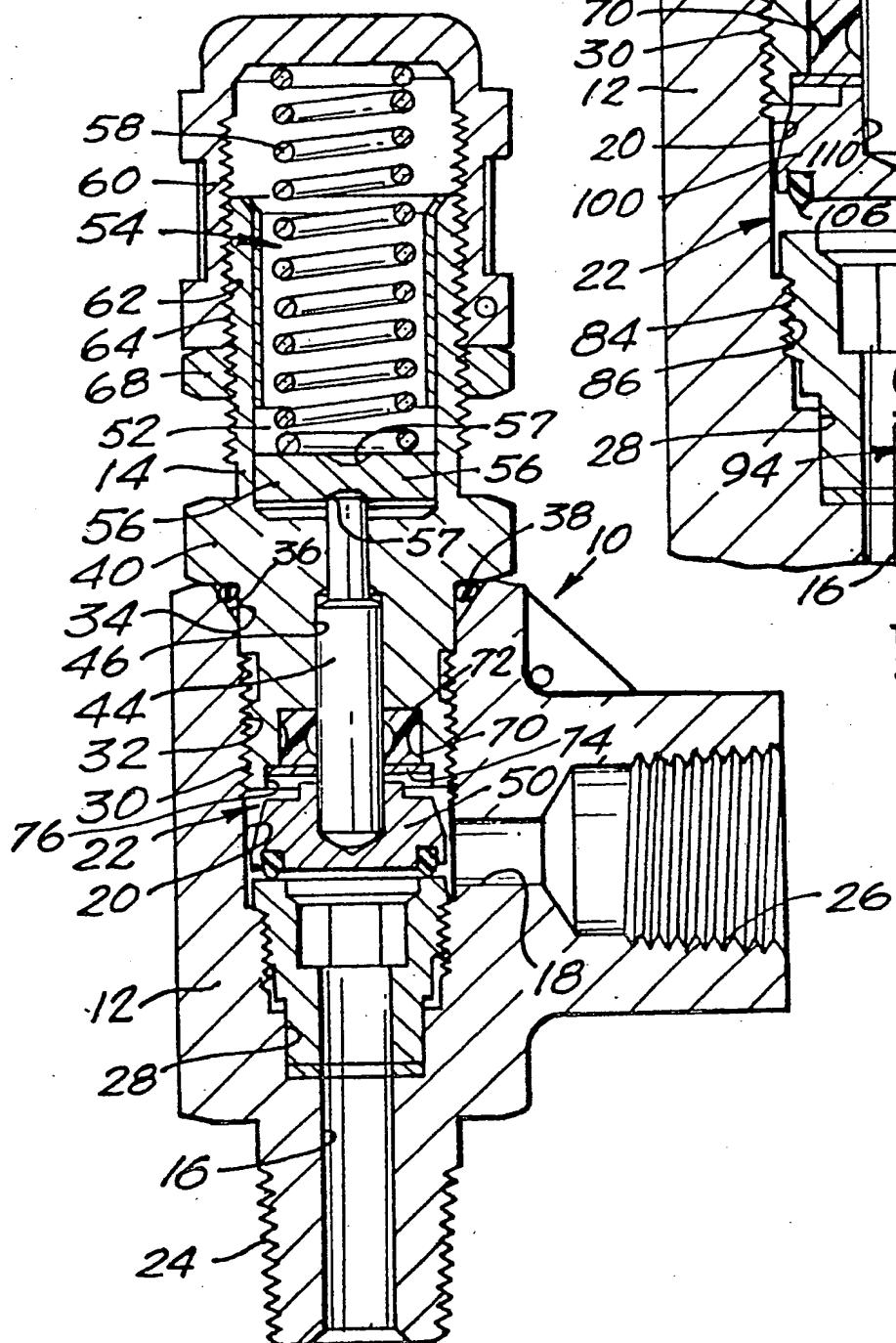
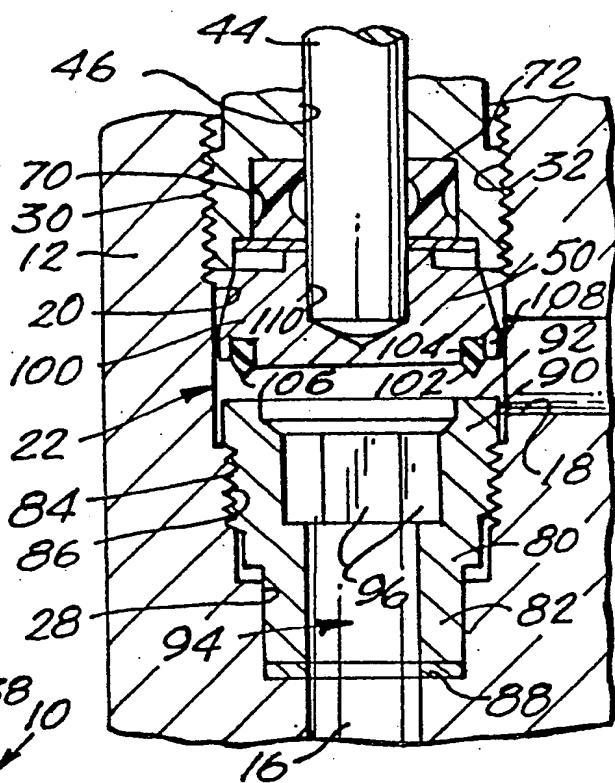


FIG. 2





DOCUMENTS CONSIDERED TO BE RELEVANT			EP 88307869.3												
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)												
Y	GB - A - 1 095 046 (SEETRU LTD.) * Fig. 1,2, belonging text *	1,5	F 16 K 17/04												
A	* Fig. 1,2, belonging text *	2,4,6, 7													
Y	DE - A1 - 3 434 809 (DRESSER INDUSTRIES INC.) * Fig. 1 *	1,5													
A	US - A - 2 597 057 (BERGQUIST) * Totality *	1,4-7													
A	CH - A5 - 625 321 (HONEYWELL BRAUKMANN GMBH) * Totality *	1,2,5- 7													
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)												
			F 16 K 17/00												
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>VIENNA</td> <td>21-11-1988</td> <td>ROUSSARIAN</td> </tr> <tr> <td colspan="2">CATEGORY OF CITED DOCUMENTS</td> <td>           T : theory or principle underlying the invention            E : earlier patent document, but published on, or after the filing date            D : document cited in the application            L : document cited for other reasons            &amp; : member of the same patent family, corresponding document         </td> </tr> <tr> <td colspan="2">           X : particularly relevant if taken alone            Y : particularly relevant if combined with another document of the same category            A : technological background            O : non-written disclosure            P : intermediate document         </td> <td></td> </tr> </table>				Place of search	Date of completion of the search	Examiner	VIENNA	21-11-1988	ROUSSARIAN	CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		
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